Name of research institute or organization:

Abteilung für Klima- und Umweltphysik, Physikalisches Institut, Universität Bern

Title of project:

CarboEurope-IP: Assessment of the European Terrestrial Carbon Balance

Project leader and team

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Project description:

The present concentration of carbon dioxide (CO_2) in the atmosphere is higher than in the past 420,000 years or maybe even in the past 20 million years, and it continues to rise. The primary causes are fossil fuel combustion and deforestation. Globally, the land biosphere (excluding the part subject to deforestation) takes up 30% of the fossil fuel emissions and thus is presently reducing the speed of anthropogenic climate change. Yet our understanding of this carbon sink, which is mainly located north of the Tropics, its partitioning between Europe, North America, and Asia, its controlling mechanisms and its vulnerability to changes in climate and land management are still uncertain. Coupled climate models indicate that, in the near future, carbon release from existing carbon pools in the biosphere could be large enough to offset any attempts of technical CO_2 emission reduction. Meeting the scientific challenge of establishing the full carbon budget of a continent with acceptable accuracy has also high political relevance because the Kyoto Protocol includes carbon sources and sinks in the terrestrial biosphere.

CarboEurope-IP aims to understand and quantify the present terrestrial carbon balance of Europe and the associated uncertainty at local, regional and continental scale.

The key innovation of the CarboEurope-IP is in its conception as to apply single comprehensive experimental strategy, and its integration into a comprehensive carbon data assimilation framework. The observational and modelling programme will run at unprecedented spatial and temporal resolution. This will allow for the first time a consistent match of bottom-up and top-down estimates of the regional variation in carbon sources and sinks.

The division of Climate and Environmental Physics at the Physics Institute of the University of Bern takes part in CarboEurope-IP through measurements of CO_2, O_2 and $\delta^{13}C$ on CO_2 on three flask sites, namely Jungfraujoch (CH), Puy de Dome (F) and Griffin (UK). Continuous records of CO_2 and O_2 have to be analysed at Jungfraujoch combined with flask analyses for $\delta^{13}C$ whereas at the other two locations only flask samples are determined.

A system for continuous measurements of O_2 and CO_2 was installed at Jungfraujoch Station on the 7th of December 2004. The CO_2 concentration is measured by a conventional infrared analyser whereas the O_2 concentration is measured with two principles, a paramagnetic technique and a fuel cell technology. The flask analyses are made on dedicated mass spectrometers.

Figure 1 summarizes the results from flask analysis from the two remote sites Jungfraujoch and Puy de Dome. We observed seasonal amplitudes of 79 per meg, 11 ppm and 0.45 ‰ for O_2/N_2, CO_2 and $\delta^{13}C$, respectively, at Jungfraujoch. At Puy de Dôme the variations are about twice as large. The O_2/N_2 and CO_2 are in opposite phase at both sites. The spring time CO_2 maximum at Puy de Dôme appears in early march, whereas at Jungfraujoch it shows up one to two months later. The O_2:CO_2 correlation gives at both sites slopes of about –2 mol O_2/mol CO_2. Stable carbon isotope ratios of source CO_2 show depleted values in wintertime and isotopically enriched values in summer.

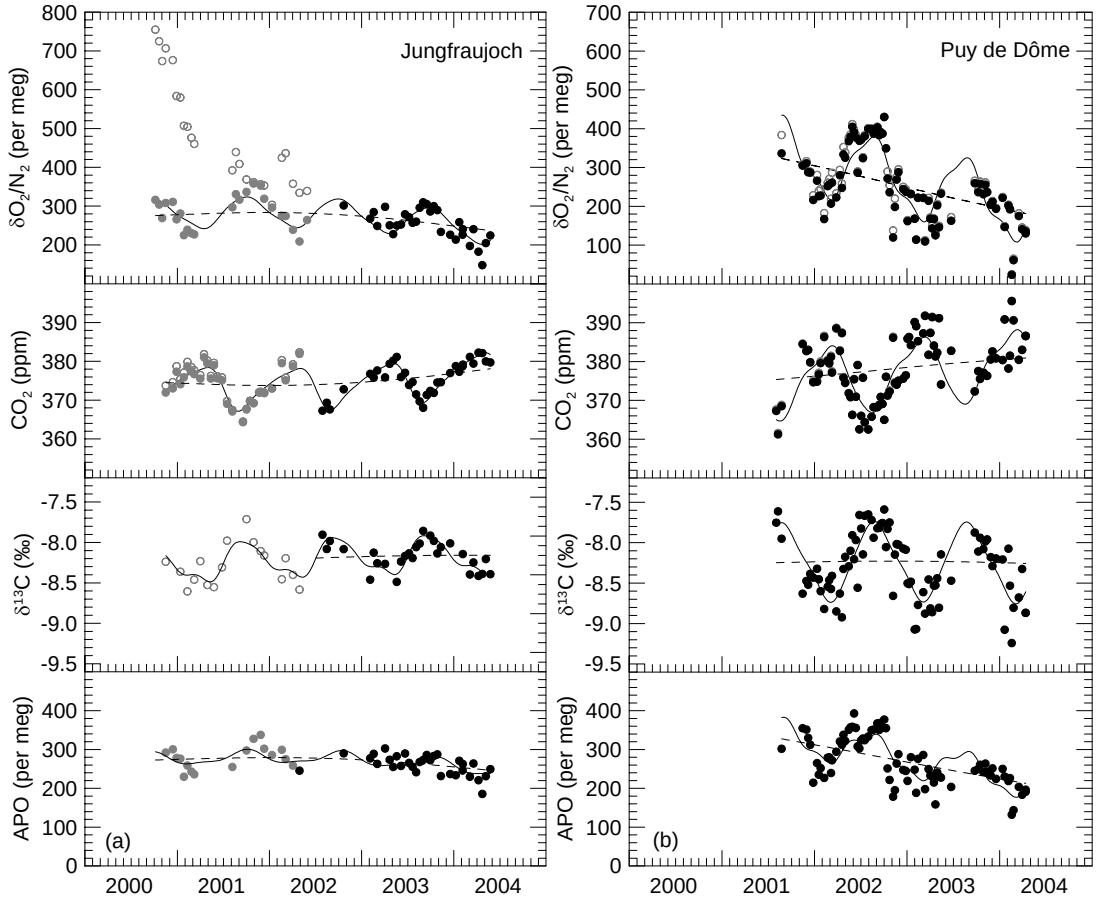

Figure 1: O_2/N_2 ratio, CO_2 mixing ratio, $\delta^{13}C$ of CO_2, and atmospheric potential oxygen (APO) from Jungfraujoch (3580m a.s.l., 46°33'N, 7°59'E). Air samples were influenced by storage drift (open circles) up to July 2002. Grey closed circles show the corrected values. Solid lines are harmonic fit curves through the data. Dashed lines represent long term trends. $\delta O_2/N_2$ results are reported on the local PIUB scale. (b) Same as (a) but for Puy de Dôme (1480m a.s.l., 45°46'N, 2°58'E).

Key words:

European carbon balance, high precision oxygen measurements, carbon dioxide, isotopes, atmospheric sampling, trace gases

Internet data bases:

http://www.lsce.cnrs-gif.fr/CE-atmosphere

Collaborating partners/networks:

Centrum voor IsotopenOnderzoek, Groningen, The Netherlands
Laboratoire des Science du Climat et de l'Environnement, UMR CEA-CNRS, CE Saclay, Gif sur Yvette, France

Scientific publications and public outreach 2004:

Refereed journal articles

Sturm, P., M. Leuenberger, C. Sirignano, R. E. M. Neubert, H. A. J. Meijer, R. Langenfelds, W. A. Brand, and Y. Tohjima, Permeation of atmospheric gases through polymer O-rings used in flasks for air sampling, J. Geophys. Res., **109**, D04309, doi:10.1029/2003JD004073, 2004.

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